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### SMOKE FROM MINNESOTA FOREST FIRES.

By HERBERT LYMAN.

[Dated: Weather Bureau, Washington, Jan. 2, 1919.]

A phenomenon of perhaps more than passing interest was witnessed from October 13 to 17, when smoke

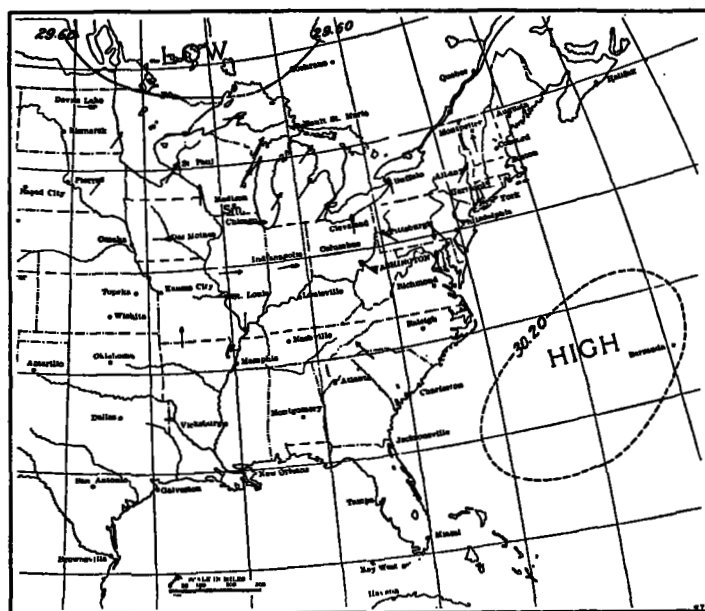


FIG. 1.—Wind distribution, 8 a. m., Oct. 12, 1918.

clouds from the great forest fires of Minnesota and adjacent sections of Wisconsin rapidly spread over a large portion of the United States east of the Missouri River. These fires, of which there were no less than six<sup>1</sup> large ones, started on October 12, 1918, following a long period of exceptionally severe drought during which the precipitation had averaged only 20 to 25 per cent of the normal. To those interested in meteorology, however, the most interesting phase of the great fires is the remarkable rapidity with which the smoke traveled. Thus, in a little over 24 hours the smoke, borne by northwest winds, reached the Atlantic seaboard, and in another 24 hours had been carried as far south as Charleston, S. C.

To trace the development and course of the smoke cloud a series of charts (figs. 1 to 8) is presented. These

<sup>1</sup> From a report to the U. S. Forest Service by National Forest Examiner John McLaren.

were made up from the Washington daily weather maps and from the monthly reports of a number of regular and cooperative Weather Bureau stations within the area under discussion.

Figure 1 shows a moderate barometric disturbance along the northern border of Minnesota and Lake Supe-



FIG. 2.—Wind and smoke distribution, p. m., Oct. 12, 1918. "Sm"—light smoke; "Sm" in circle—dense smoke.

rior on Saturday morning, October 12, only a few hours before the forest-fire smoke was first noticed. In Duluth, which was quite near the conflagrations, the weather was fine and clear in the morning. Shortly

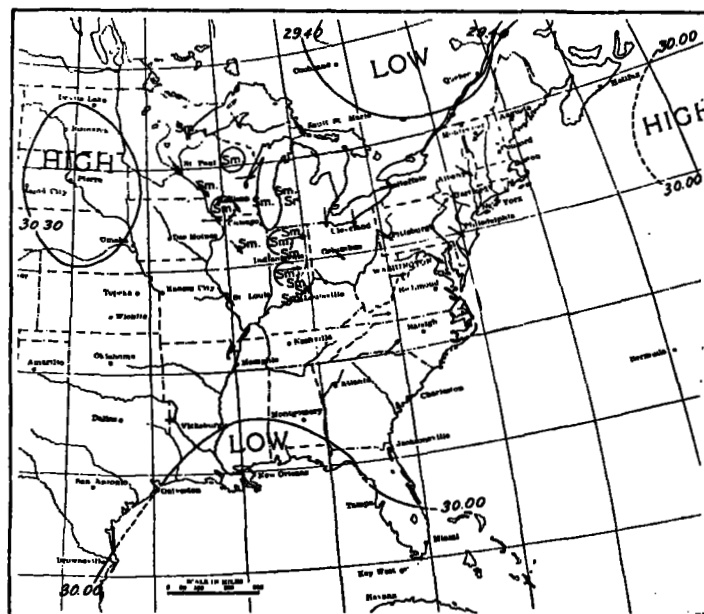


FIG. 3.—Wind and smoke distribution, a. m., Oct. 13, 1918. "Sm"—light smoke; "Sm" in a circle—dense smoke.

before noon smoke appeared in the west and became rapidly denser until 3 o'clock when the sun was entirely obscured. By 4:30 p. m. the city lights had to be turned on. Figure 2, shows the cyclonic depression covering the entire Lake region with the center over Montreal. By the following morning, October 13 (fig. 3), this low had

moved to eastern Ontario, while in the West a high area had advanced to the Dakotas. Twelve hours later the low had reached the mouth of the St. Lawrence (fig. 4). With high pressure continuing in the Dakotas and a shallow low in the Gulf, northwesterly winds naturally

Valley. At the same time a LOW was centered over Pierre, S. Dak., and another over the Gulf. The resultant winds spread the smoke still farther southward beyond College Station, Tex., in the west, and Thomasville, Ga. in the east.



FIG. 4.—Wind and smoke distribution, p. m., Oct. 13, 1918. "Sm."—light smoke; "Sm." in a circle—dense smoke.

prevailed from Minnesota eastward thus carrying the smoke cloud to the Atlantic coast by about 10 p. m. of the 13th.

The chart for the morning of the 14th (fig. 5) shows the Dakota HIGH extending eastward to Ohio and southwest-

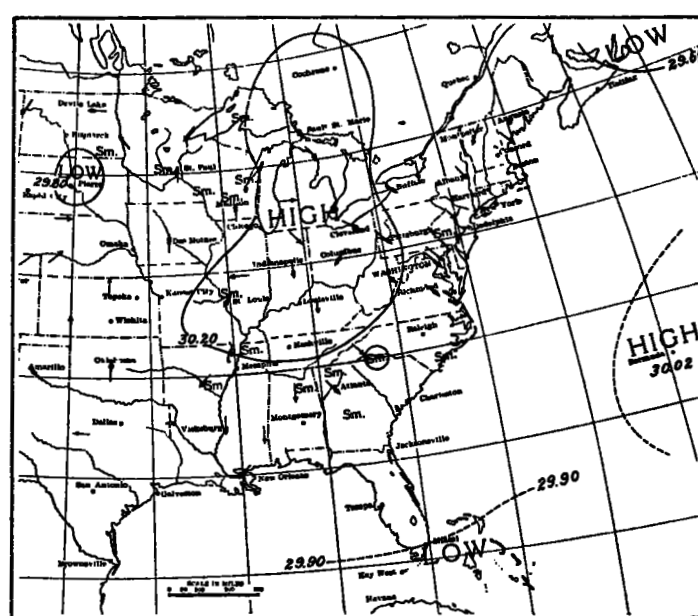


FIG. 6.—Wind and smoke distribution, p. m., Oct. 14, 1918. "Sm."—light smoke; "Sm." in a circle—dense smoke.

Figure 7 (p. m., Oct. 15), with easterly winds at North and South Dakota stations, shows how the smoke drifted westward from Minnesota.

Figure 8 (p. m., Oct. 16) shows the smoke cloud still covering a wide range of territory, extending from Valen-

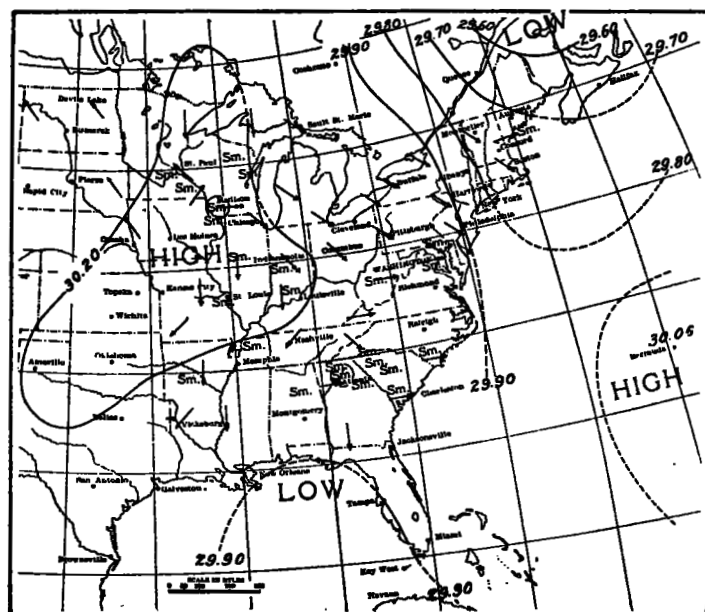


FIG. 5.—Wind and smoke distribution, a. m., Oct. 14, 1918. "Sm."—light smoke; "Sm." in a circle—dense smoke.

ward to northern Texas. In the Gulf the pressure is still low. This pressure system resulted in winds that carried the smoke southward to Little Rock, Ark., on the west, and to Charleston, S. C., on the Atlantic coast. By the night of the 14th (fig. 6) the HIGH had moved eastward, occupying the Lower Lakes and the Ohio



FIG. 7.—Wind and smoke distribution, p. m., Oct. 15, 1918. "Sm."—light smoke; "Sm." in a circle—dense smoke. Smoke also in E. Texas.

tine, Nebr., to Portland, Me., and from the Lakes to Little Rock, Ark., and Greenville, S. C.

Extracts from the meteorological notes of a number of regular and cooperative Weather Bureau stations, and from other interested observers are appended:

## OCTOBER 12.

**Duluth, Minn.**—The outstanding feature of the month was the 50 to 60 mile westerly gale which occurred on the afternoon and night of the 12th and which was attended by the devastating forest fires which swept over this section at that time, resulting in enormous loss of life and property.

During the afternoon and night of the 12th a devastating forest-brush fire swept over large areas in St. Louis and adjoining counties in northeast Minnesota, the total area of more or less complete fire destruction being approximately 1,500 square miles. Places as large as Cloquet and Moose Lake were completely wiped out, and the fire area included suburban sections in and near Duluth. Many small towns were also destroyed, including hundreds of settlers' and farmers' homes and all their property. Approximately 1,000 lives were lost, hundreds were seriously burned, and thousands narrowly escaped. The property loss has been variously estimated as running between \$50,000,000 and \$100,000,000. It will require some time to determine fully the exact life and property losses. Thousands of refugees were cared for in Duluth, Superior, and other places. Literally thousands were saved through prompt action on the part of the railroads, motor corps, Home Guards, and citizens, who furnished automobiles. Fifty or more automobiles were destroyed in this life-saving effort. Relief and rehabilitation measures were prompt, most generous, and well organized. The rehabilitation feature will be continued indefinitely. The fire was attended by a tremendous gale, probably to a large extent created by the fire itself, as the meteorological conditions



FIG. 8.—Wind and smoke distribution, p. m., Oct. 16, 1918. "Sm"—light smoke; Sm. in a circle—dense smoke.

avored but a fresh wind. During the worst period of the fire (4 p. m. to 9 p. m.) the wind blew at rates varying from 50 to 65 miles per hour and from westerly directions. Brush and peat bog fires had been burning for some time previous, but no grave danger was anticipated. The fire's progress and development were enhanced by reason of the prevalent record-breaking dry season and the fresh wind which developed on the date of the catastrophe. Such warning as was immediately possible was duly made, and the probability of such a fire had been given some previous attention on the part of the forest rangers and others.

## OCTOBER 13.

**Madison, Wis.**—Dense smoke from Minnesota forest fires began during the night. Continued smoky all day, probably not enough to be called "dense" in the afternoon. Moon and stars visible near the zenith in the evening, but stars obscured near the horizon.

**Wausau, Wis.**—Smoke from the forest fires in northern Minnesota was observed.

**Grand Haven, Mich.**—On the 13th the entire sky was colored pink before and at sunrise; shortly after sunrise it rapidly took on a yellowish-green hue. Light smoke prevailed at the time. The green faded rapidly as the sun rose higher. The smoke was almost dense from 8 a. m. to 11 a. m.

<sup>1</sup> The gale may have been the result (1) of a local heat cyclone produced by the fire, and (2) of the large amount of convective interchange which brought to the earth great quantities of the higher, more rapidly moving air.—E.D.

**Lansing, Mich.**—On Sunday morning, October 13, a dense sheet of smoke filled the atmosphere, causing a peculiar coppery color of the sunlight. On the previous day there occurred extensive forest fires in Wisconsin and Minnesota, and it is thought that the northwest winds then prevailing may have brought the smoke to this station.

**Port Huron, Mich.**—On the morning of the 13th the early morning light was of a peculiar greenish-yellow color, which was doubtless due to light smoke which prevailed from some time before daylight until 8:30 a. m. The smoke seemed to be more thick aloft than at the surface of the earth. The peculiar aspect of the sky disappeared with the smoke. It is thought that the smoke came from forest fires which were reported in the daily press as burning in northern Minnesota for a day or so previously, as the wind was west and northwest at the time. Some people became alarmed and inquiries were received as to the cause.

**Fort Wayne, Ind.**—Light smoke and light haze were observed on the 13th.

**Howe, Ind.**—The sun looked like a red moon, caused from smoke of forest fires [in Minnesota].

**Indianapolis, Ind.**—Smoke from extensive forest fires in northern Minnesota and Wisconsin first made its effect noticeable here at 8:30 a. m. The sun's rays gradually became fainter and of a bright red color, and there was an odor as of burning leaves. The smoke was most dense in the late afternoon and lessened during the night.

**Mauzy, Ind.**—Dense smoke during the latter part of the day. Sun invisible at 5 p. m.

**Salamonia, Ind.**—Smoky all day from the great forest fires near Duluth.

**Scottsburg, Ind.**—Quite heavy smoke, with odor of burning leaves, appeared from the northwest at about 4:30 p. m.

**Bangorville, Ohio.**—Smoke very dense from the northwestern fires.

**Cadiz, Ohio.**—Smell of burning wood on the 13th; very smoky.

**Canton, Ohio.**—Heavy smoke from forest fires on the afternoon of the 13th.

**Cincinnati, Ohio.**—Unusual conditions prevailed during the afternoon and evening of Sunday, October 13. Cloudy weather, which prevailed during the early morning, cleared at about 7:30 a. m. The sky was clear until shortly after noon, when a few cirrus clouds had formed. Thereafter the sky was gradually covered with a haze and smoke, which was moderately dense from 1:20 p. m. to 2:10 p. m. After this time the smoke virtually disappeared, and while light haze was visible, no cloud formation could be seen. At 3 p. m. the smoke and haze became denser, but the sun's light and its disk could be seen until 3:35 p. m., at which time the sun was entirely obscured. Objects at this time could not be seen at a distance of 300 feet. Similar conditions prevailed in all surrounding regions. At 3:45 p. m. the haze and smoke, although dense, were not sufficient to obscure the sun and it was still visible as a dim red ball at both College Hill and Fort Thomas, Ky., two of the highest neighboring localities.

**Cleveland, Ohio.**—Light smoke was first observed shortly after 6 a. m., becoming dense at 11 a. m., dense smoke continuing until 1:30 p. m., when it became light. Light smoke ended about 2:25 p. m. The smoke had the odor of burning brush, and was brought to this city by west and northwest winds.

**Columbus, Ohio.**—Dense smoke, apparently from the forest fires of northeast Minnesota, prevailed throughout the afternoon of this date, gradually merging into cloud during the late afternoon hours.

**Dayton, Ohio.**—An unusual condition of the sky prevailed on the 13th, which was assumed to be directly connected with the extensive forest fires in Minnesota and Wisconsin. The sky was overcast early in the morning with strato-cumulus clouds but the lower stratum of the atmosphere was comparatively clear. About 8 a. m. the clouds dissipated and for two hours the sky was almost perfectly clear. It began to present a hazy appearance about 10 a. m. Within half an hour the smoke became so dense as to give the sun the appearance of an orange-colored ball and shortly after noon it was almost completely obscured and remained so the remainder of the day. The smoke disappeared completely during the night, but the moon was obscured up to 10 p. m. or later.

**Hiram, Ohio.**—A yellow sky with blood-red sun from 10 a. m. to 2 p. m., due to smoke from forest fires in Minnesota. The smell of burnt leaves was plain.

**Lima, Ohio.**—Very smoky.

**McConnellsville, Ohio.**—In the afternoon the landscape was covered with smoky haze brought in by the northwest winds which blew strongly. The sun appeared as a red ball.

**Ottawa, Ohio.**—A peculiar yellow tint prevailed over this vicinity; also told that same was true at Toledo by persons living there, who thought it was caused by smoke of the Wisconsin fires.

**Sidney, Ohio.**—Smoke settled in valley here from Wisconsin forest fires.

**Vickery, Ohio.**—Very smoky all the forenoon from Minnesota and Wisconsin forest fires.

**Albany, N. Y.**—On Sunday afternoon, October 13, 1918, a light rain accompanied by an unusual smoky condition of the air was observed at my laboratory 9 miles west from Albany, N. Y. The conditions were as follows: During the afternoon there was a steady wind from the south

of about 4 miles per hour measured at the evaporation station anemometer 2 feet above ground. The sky was partly overcast with clouds at medium height. At 4:35 p. m., clock time, the wind was heard rushing through the woods at some distance, the sky became suddenly overcast with low uniform clouds, there was a sudden gust of strong wind from the west accompanied and followed by dense smoke with a strong smell of burning wood. The temperature dropped from 62° to 51° and the rainfall measured by the Friez recording gage was 0.05 inch between 4:49 and 5:02 p. m. The appearance and odor of smoke was so strong and came so suddenly that one instinctively looked about for a fire in the woods.

The conditions apparently were produced by a layer of cool air underrunning the sluggish, warm and humid surface air which had prevailed throughout the afternoon, forcing it upward with extreme suddenness and producing the light rain. Being interested in the question of the origin of the smoke I made inquiries at Little Falls, located 73 miles west from Albany in the Mohawk Valley, and learned that substantially the same phenomenon as regards wind conditions and the appearance and odor of wood smoke were observed there at very nearly 4 p. m., clock time. \* \* \* In view of the prevailing forest fires of Minnesota the question arises as to the possibility of a connection between this smoke-bearing wind gust and these fires. The air in the Mohawk Valley had been remarkably clear for this season of the year prior to the smoke storm of October 13.—*R. E. Horton.*

*Brockport, N. Y.*—Sunday, October 13, the light was a curious greenish-yellow until after 2 p. m.

*Ithaca, N. Y.*—Atmospheric conditions of Sunday, October 13, presented a heavy, smoky appearance in the northern and western sections of the State. The sun and sunlight took a curious greenish-yellow appearance which, in some respects, was not unlike full moon and moonlight in some localities, while in other parts the atmosphere seemed to have been filled completely with a dismal contour of hazy yellow clouds, causing the day to be termed by some as a "yellow" day. In still other places the sun appeared like a bright ball of fire peering through the hazy sheen. Unquestionably the peculiar appearance was due to a heavy pall of smoke, which is believed to have been wafted eastward and southeastward over the Great Lakes by high winds of a strong anticyclonic area of atmospheric pressure from the northeastern sections of Minnesota, where disastrous forest fires that destroyed several towns and cost many lives, raged for some days previous to the "yellow" day of the 13th.

*Raquette Lake, N. Y.*—From 4 to 5 p. m. unusual sun and sunlight, more like full moon and moonlight.

*Wedgwood, N. Y.*—A dense smoke with smell of burning leaves observed in the p. m. The sun appeared like a ball of fire.

*Burlington, Vt.*—Atmosphere very smoky in the afternoon, clearing away shortly after sunset.

*New Haven, Conn.*—Light smoke was observed during the evening.

*Pittsburgh, Pa.*—On the 13th dense smoke having a woody odor was observed in the afternoon during a 20-mile wind. The sky was almost copper-colored and the pungent, acrid odor was noted throughout the Pittsburgh district, causing difficulty in breathing, a smarting and burning of the eyes.

*Elkins, W. Va.*—The smoke of the 13th is believed to have been due to the great Minnesota fires.

*Smithfield, W. Va.*—On Sunday evening, October 13, for some hours the town was filled with smoke from forest fires in west.

*Baltimore, Md.*—Light smoke set in at 9:50 p. m. and became dense at 10:15 p. m.

*Washington, D. C.*—A beautifully clear evening until about 10 p. m., when light smoke, with a strong odor of burning wood, was noticeable. By 10:30 p. m. the smoke cloud became denser, and was distinctly visible over the face of the moon. By 11 p. m. the moon and stars had disappeared, and street-lights half a block distant were appreciably dimmed.

#### OCTOBER 14.

*Madison, Wis.*—Dense smoke from some time in the night to 9 a. m. Light smoke from 9 a. m. to some time during the night.

*Wausau, Wis.*—Smoke from the forest fires in northern Minnesota and Wisconsin was observed.

*Portland, Me.*—Light smoke observed.

*Elkins, W. Va.*—Smoke on the 14th believed to have been due to the great Minnesota forest fires.

*Greenville, S. C.*—Light smoke from early morning until about 10 a. m., which merged into a light haze during the following night.

#### OCTOBER 15.

*Washington, D. C.*—Dark layer of haze or smoke on the western horizon in the morning increased in elevation and became lighter in color as the day advanced.

*Macon, Ga.*—Sky covered most of the day with Ci. St. clouds moving from the west and northwest. With these there was a generally hazy or smoky condition of the air strata.

*Thomasville, Ga.*—Light smoke was observed to-day.

*College Station, Tex.*—At 8:20 a. m. there was an unusual amount of haze; and at 10:40 there was a well-defined smell of forest fire smoke and the haze had become dense. Evidently, this was smoke from the Minnesota fires having come in the lower air around the front of the large north-south high pressure area.—*C. F. Brooks.*

*Devils Lake, N. Dak.*—Mention is made of the smoky condition of the atmosphere. Easterly winds on the 15th and 16th drifted the smoke from the large forest fires of northern Minnesota over this district.

*Ellendale, N. Dak.*—Light smoke occurred on the 15th and 16th. It was no doubt due to the great forest fires raging in northeastern Minnesota.

#### OCTOBER 16.

*Ludington, Mich.*—Considerable smoke on the 16th and on several days previous, due mostly, it is thought, to forest fires in Minnesota.

*Columbus, Ohio.*—Light smoke noted in the upper air from 1:30 p. m. to 5 p. m. Aviators at a height of 3,500 feet were not visible.

*Portland, Me.*—Light smoke recorded.

*College Station, Tex.*—Smoke limited visibility to 3 km., odor still apparent.—*C. F. B.*

*Williston, N. Dak.*—Light smoke, presumably from forest fires in the northeast during the day.

#### OCTOBER 17.

*Portland, Me.*—Light smoke recorded.

*College Station, Tex.*—Most of smoke gone.—*C. F. B.*

*Lodge Pole, Nebr.*—Smoke so dense can not see sun.

*Valentine, Nebr.*—A pall of smoke hung over this station from the 17th to the 19th, inclusive. This smoke came from northeastern Minnesota, where disastrous forest fires had raged several days before.

#### SUMMARY.

From the foregoing the following facts stand out. On the 12th of October great forest fires raged in northeastern Minnesota and adjoining portions of Wisconsin. At Duluth the smoke became dense about the middle of the afternoon. By the following morning (13th) the smoke cloud had overspread the Michigan Peninsula and central Indiana. In the next 12 hours strong northwest winds had extended this cloud across Ohio into New York, Pennsylvania, West Virginia, Maryland, and the District of Columbia, the two latter being reached shortly after 10 p. m. On the morning of the 14th, the smoke had spread as far south as Charleston, S. C. and Little Rock, Ark., and in another day more than 300 miles farther. On the 15th, easterly winds set in in western Minnesota. The smoke cloud was carried across North Dakota on the 16th and into Nebraska on the following day.

#### EFFECTS OF HURRICANES ON THE UPPER-AIR CURRENTS.

By Prof. WILLIAM H. PICKERING.

[Dated: Harvard College Observatory, Mandeville, Jamaica, B. W. I., Dec. 10, 1918.]

A short note under the above heading appeared in the MONTHLY WEATHER REVIEW for October, 1915, 43, 496-497.<sup>1</sup> A piece of negative testimony on the same subject has just been obtained here. It was there shown that if we pointed a telescope to a bright star near the zenith, and then drew out the eyepiece 2 or 3 millimeters, so as to throw the image out of focus, a round disk of light would be obtained from which we could draw conclusions as to the condition of the upper air currents. In the temperate zone parallel lines crossing this image are not infrequently seen. They never appear in the tropics, however, unless some serious disturbance is at hand. They then lie in a direction parallel to the motion of the disturbance. In September, 1915, we were in this manner able to foretell a hurricane

<sup>1</sup> There is a longer, illustrated article by A. E. Douglass on "The study of atmospheric currents by the aid of large telescopes, and the effect of such currents on the quality of the seeing," in *Am. Meteorological Jour.* 1895, 11:395-409.—*Ed.*